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Landslide detection and long-term monitoring in urban area by means of advanced interferometric techniques

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This work aims at illustrating the potential of advanced interferometric techniques for detection and long-term monitoring of landslide ground deformations at local scale.

Space-born InSAR (Synthetic Aperture Radar Interferometry) has been successfully exploited in recent years to measure ground deformations associated to processes with slow kinematics, such as landslides, tectonic motions, subsidence or volcanic activity, thanks to both the standard single-interferogram approach (centimeter accuracy) and advanced time-series analyses of long temporal radar satellite data stacks (millimeter accuracy), such as Persistent Scatterers Interferometry (PSI) techniques.

In order to get a complete overview and an in-depth knowledge of an investigated landslide, InSAR satellite measures can support conventional in situ data. This methodology allows studying the spatial pattern and the temporal evolution of ground deformations, improving the spatial coverage and overcoming issues related to installation of ground-based instrumentation and data acquisition in unstable areas.

Here we describe the application of the above-mentioned methodology on the test area of Agrigento, Sicily (Italy), affected by hydrogeological risk. The town is located in Southern Sicily, at edge of the Apennine-Maghrebian thrust belt, on the Plio-Pleistocene and Miocene sediments of the Gela Nappe. Ground instabilities affect the urban area and involve the infrastructures of its NW side, such as the Cathedral, the Seminary and many private buildings. An integration between InSAR analyses and conventional field investigations (e.g. structural damages and fractures surveys) was therefore carried out, to support Regional Civil Protection authorities for emergency management and risk mitigation.

The results of InSAR analysis highlighted a general stability of the whole urban area between 1992 and 2007. However, very high deformation rates (up to 10-12 mm/y) were identified in 1992-2000 in the W slope of the town, within the crown and the main scarp area of the Addolorata landslide (occurred in July 1966), and thus was highlighted that the phenomenon was still active. The time-series analysis performed in the NW area of the town, also allowed measuring acceleration (up to 13 mm/y) of the deformation rates near the main Cathedral, starting from August 2006 and persisting until the end of the monitoring period (2007). The new information about the state of activity of these landslides were discussed with the Civil Protection authorities to plan further field investigations and structural surveys to be carried out in the areas at higher risk.

The analysis on Agrigento confirmed the capabilities of this integrated approach for detection of ground deformations, long-term monitoring of landslides and, finally, management and mitigation of hydrogeological risk in urban area at local scale.